

To our customers,

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## Old Company Name in Catalogs and Other Documents

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Renesas Electronics website: <http://www.renesas.com>

April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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Not recommended  
for new design

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# HSG2005

## SiGe HBT High Frequency Medium Power Amplifier

REJ03G0485-0400

Rev.4.00

Jun 21, 2006

### Features

- High Transition Frequency  
 $f_T = 28.5$  GHz typ.
- Low Distortion and Excellent Linearity  
P1dB at output = +21 dBm typ.  $f = 5.8$  GHz
- High Collector to Emitter Voltage  
 $V_{CEO} = 5$  V
- Ideal for 2 GHz, 5 GHz Band applications. e.g. WLAN, Digital cordless phone.

### Outline

Renesas Package code: PWQN0008ZA-A  
(Package name: HWQFN-8 <TNP-8TV>)



1. Collector
2. Collector
3. Collector
4. Emitter
5. Emitter
6. Base
7. Emitter
8. Emitter
9. Emitter

Note: Marking is "2005".

### Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Item	Symbol	Ratings	Unit
Collector to base voltage	$V_{CBO}$	12	V
Collector to emitter voltage	$V_{CEO}$	5	V
Emitter to base voltage	$V_{EBO}$	1.2	V
Collector current	$I_C$	400	mA
Collector power dissipation	$P_C$	1.2 <sup>Note</sup>	W
Junction temperature	$T_j$	150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to +150	$^\circ\text{C}$

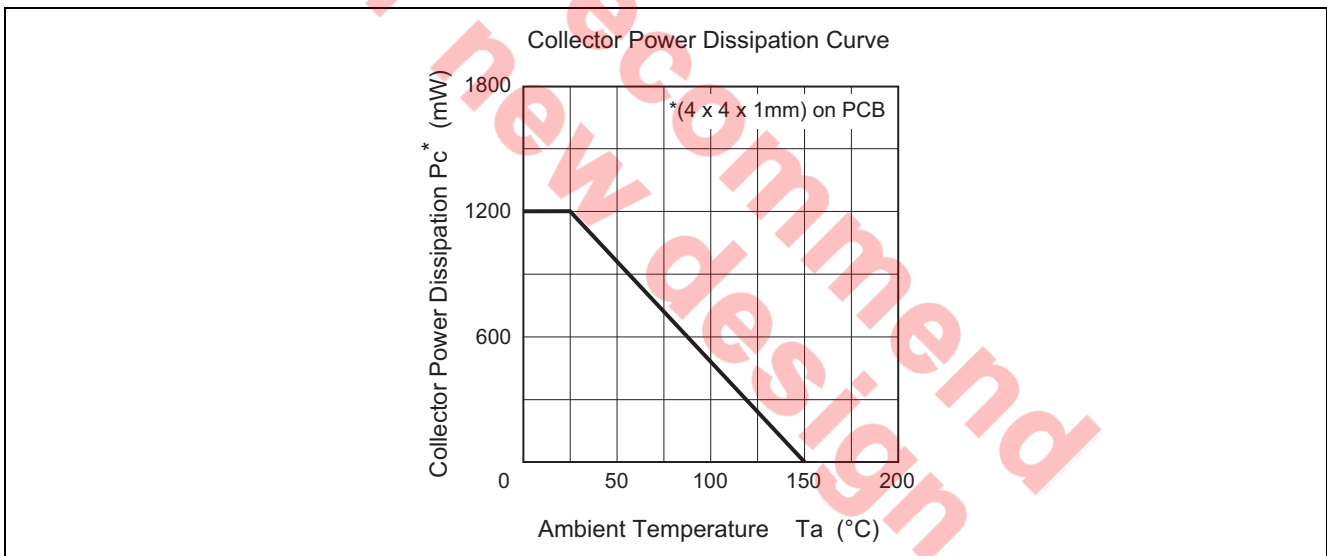
Note: Value on PCB (40 x 40 x 1.0 mm)

## Electrical Characteristics

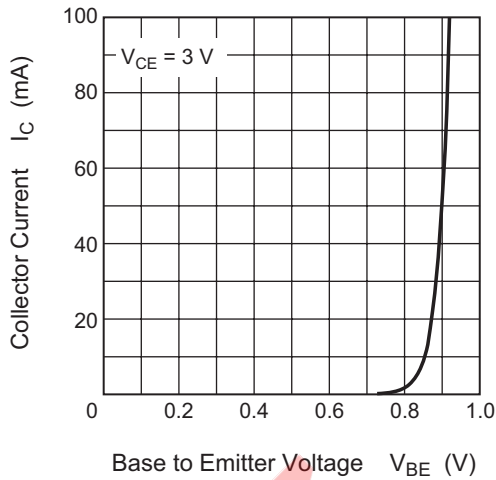
(Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
DC current transfer ratio	$h_{FE}$	150	220	300	—	$V_{CE} = 3\text{ V}$ , $I_C = 100\text{ mA}$
Reverse Transfer Capacitance	$C_{re}$	—	—	0.4	pF	$V_{CB} = 3\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ , emitter grounded
Transition Frequency	$f_T$	—	28.5	—	GHz	$V_{CE} = 3\text{ V}$ , $I_C = 100\text{ mA}$ , $f = 1\text{ GHz}$
Maximum Stable Gain	MSG	10.5	12.5	—	dB	$V_{CE} = 3\text{ V}$ , $I_C = 100\text{ mA}$ , $f = 5.8\text{ GHz}$
Maximum Available Gain	MAG	—	17.0	—	dB	$V_{CE} = 3\text{ V}$ , $I_C = 100\text{ mA}$ , $f = 2.4\text{ GHz}$
Maximum Available Gain	MAG	—	9.0	—	dB	$V_{CE} = 3\text{ V}$ , $I_C = 100\text{ mA}$ , $f = 5.8\text{ GHz}$
Power Gain	PG	—	8.0	—	dB	$V_{CE} = 3.6\text{ V}$ , $I_{idle} = 100\text{ mA}$ , $f = 5.8\text{ GHz}$ , $P_{in} = +13\text{ dBm}$
1dB Compression Point at output	P1dB	—	+21	—	dBm	$V_{CE} = 3.6\text{ V}$ , $I_{idle} = 100\text{ mA}$ , $f = 5.8\text{ GHz}$
Saturation Output Power	Po(sat)	—	+23	—	dBm	$V_{CE} = 3.6\text{ V}$ , $I_{idle} = 100\text{ mA}$ , $f = 5.8\text{ GHz}$ , $P_{in} = +13\text{ dBm}$

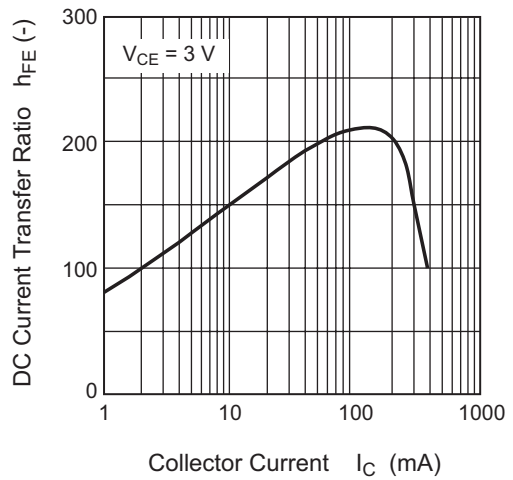
## Main Characteristics



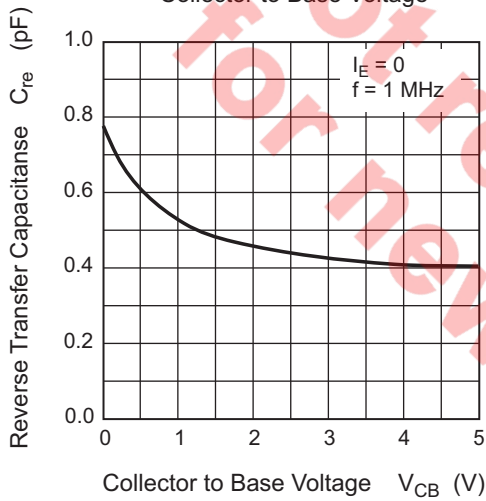
Typical Transfer Characteristics



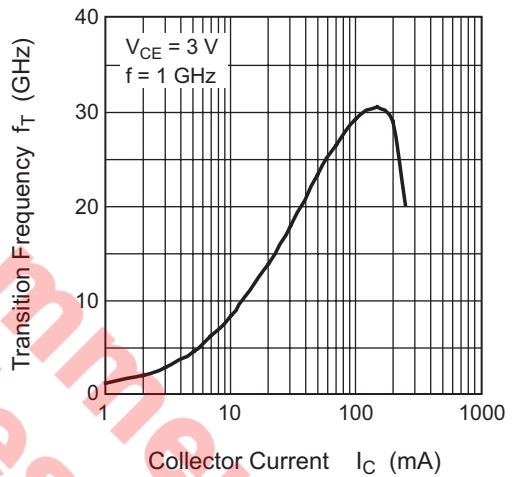
DC Current Transfer Ratio vs. Collector Current



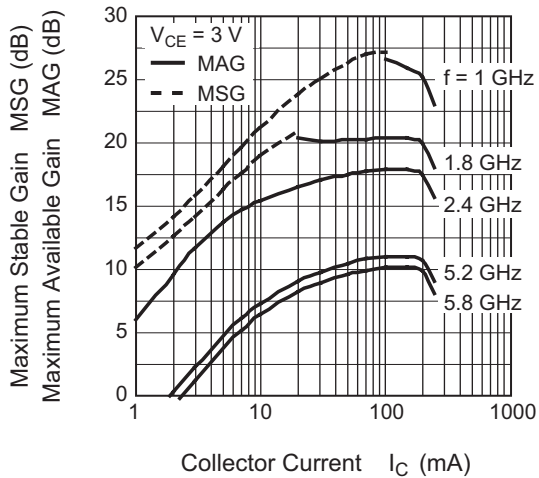
Reverse Transfer Capacitance vs. Collector to Base Voltage



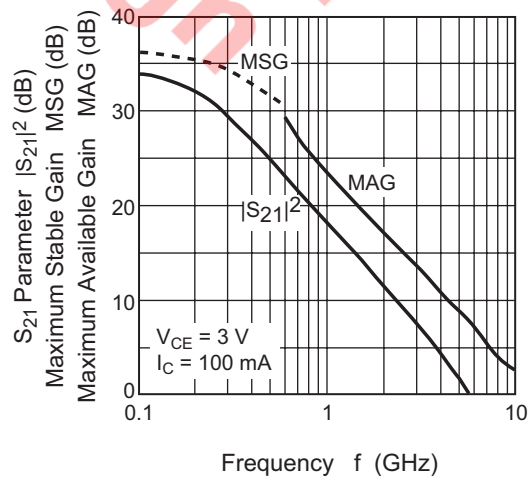
Transition Frequency vs. Collector Current



Maximum Stable Gain, Maximum Available Gain vs. Collector Current

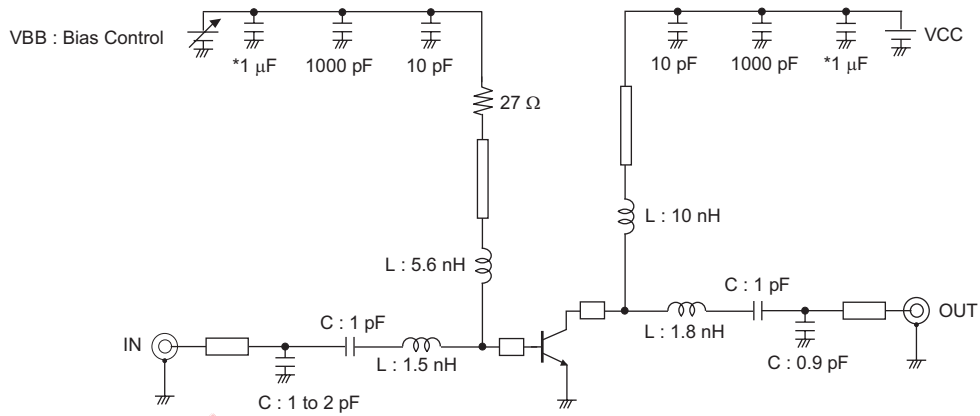


$S_{21}$  Parameter, Maximum Stable Gain, Maximum Available Gain vs. Frequency

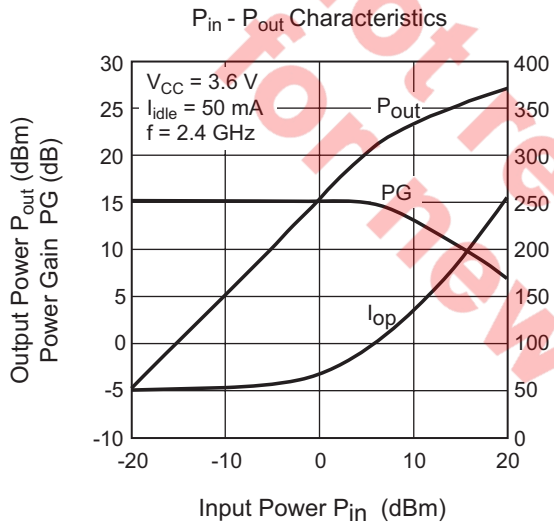


## 2.4 GHz Characteristics

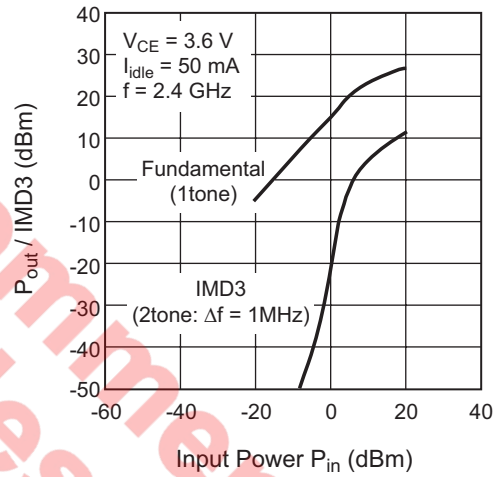
Evaluation Board Circuit



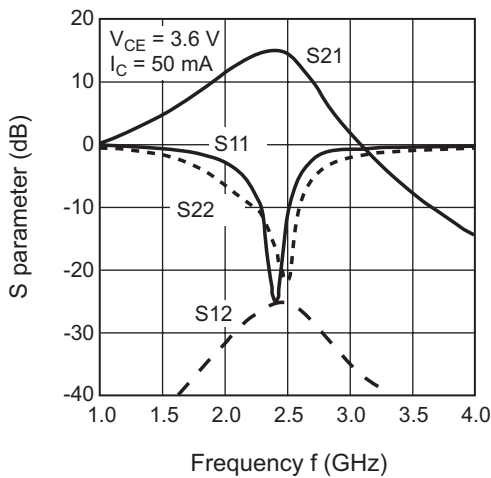
Pin - Pout Characteristics



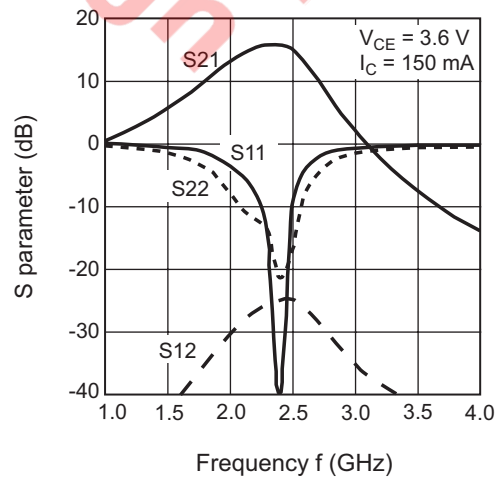
3rd. Order Intermodulation Distortion (IMD3)



S parameter vs. Frequency

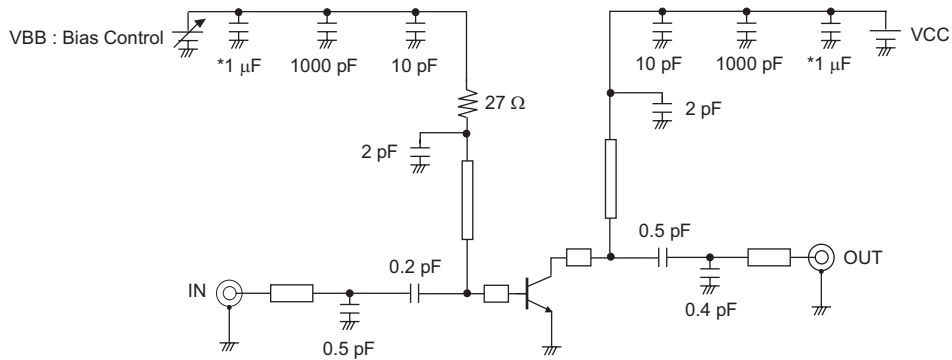


S parameter vs. Frequency

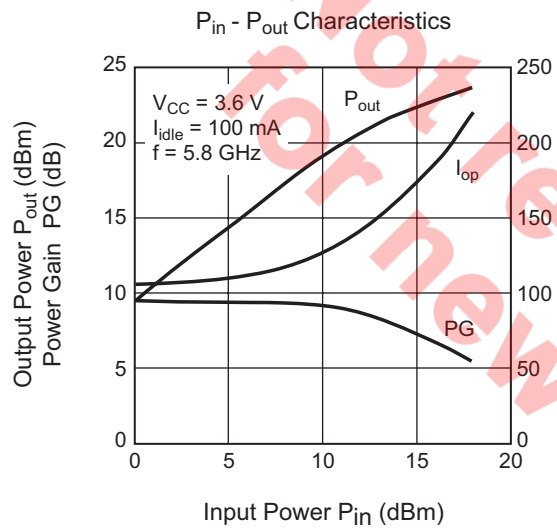


### 5.8 GHz Characteristics

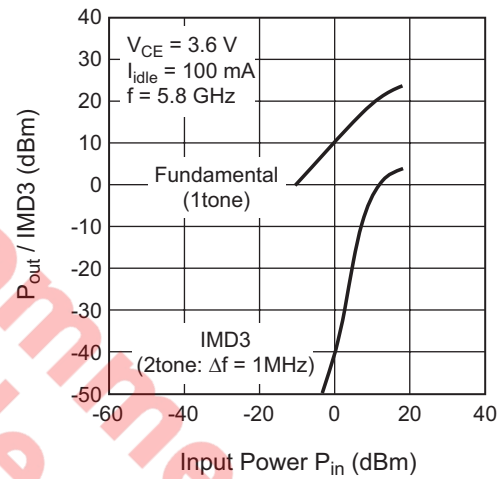
Evaluation Board Circuit



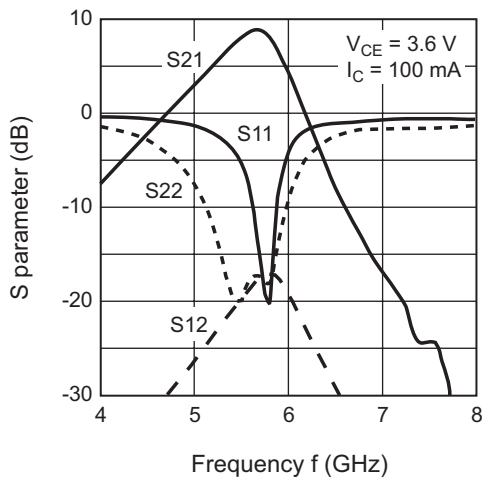
Pin - Pout Characteristics



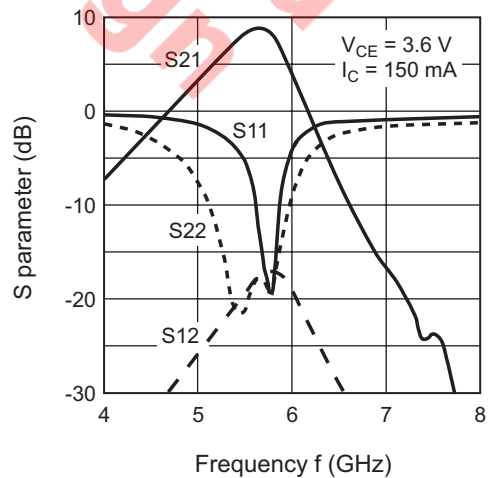
3rd. Order Intermodulation Distortion (IMD3)



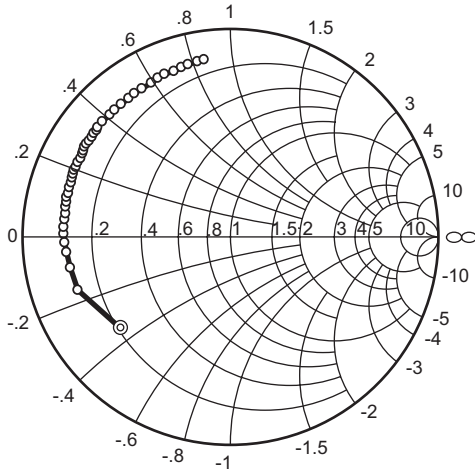
S parameter vs. Frequency



S parameter vs. Frequency

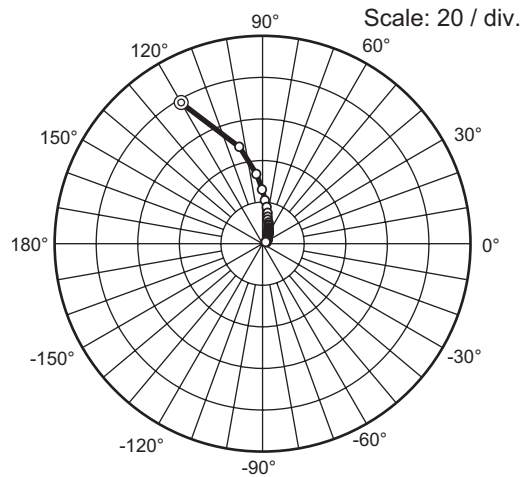


S<sub>11</sub> Parameter vs. Frequency



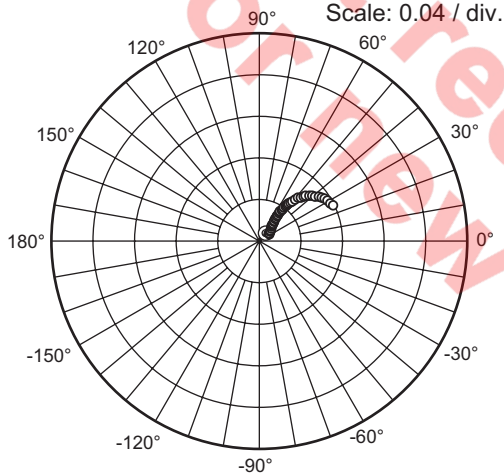
Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>21</sub> Parameter vs. Frequency



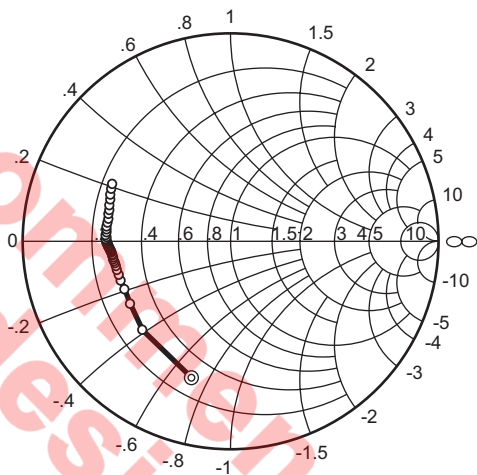
Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>12</sub> Parameter vs. Frequency



Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

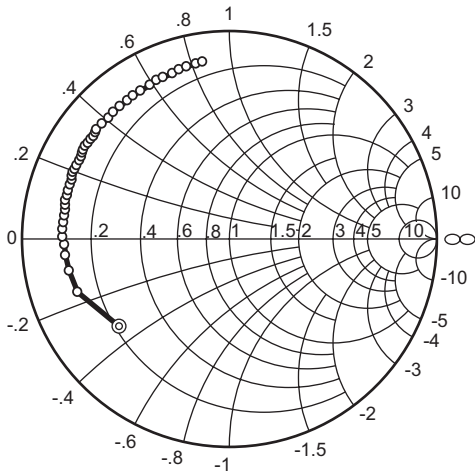
S<sub>22</sub> Parameter vs. Frequency



Condition:  $V_{CE} = 3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

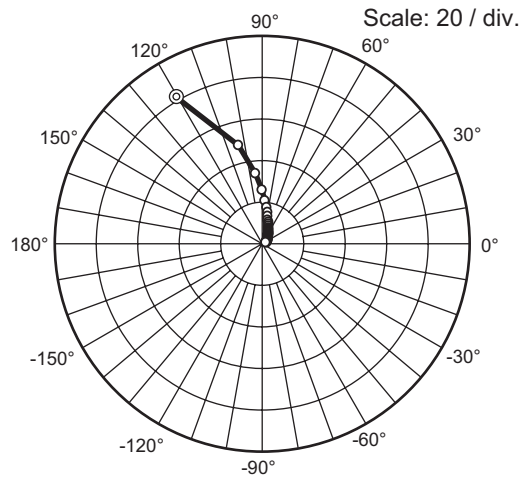


S<sub>11</sub> Parameter vs. Frequency



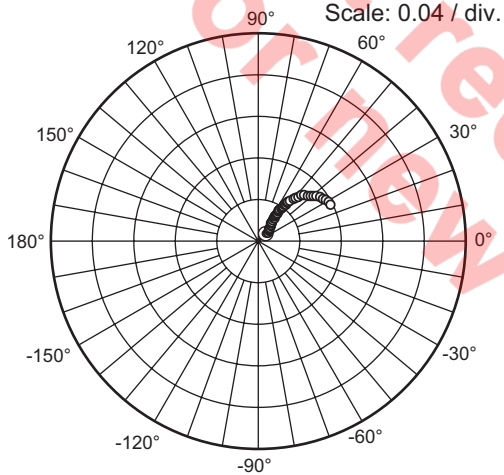
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>21</sub> Parameter vs. Frequency



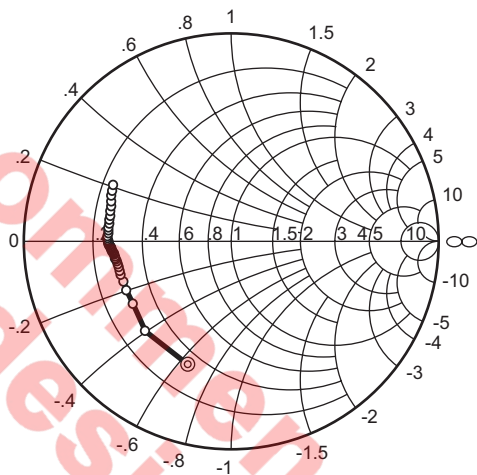
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>12</sub> Parameter vs. Frequency



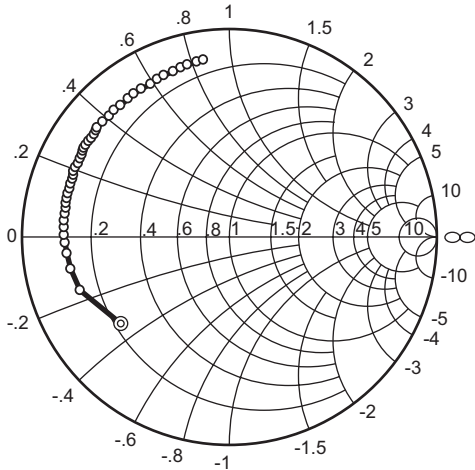
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>22</sub> Parameter vs. Frequency



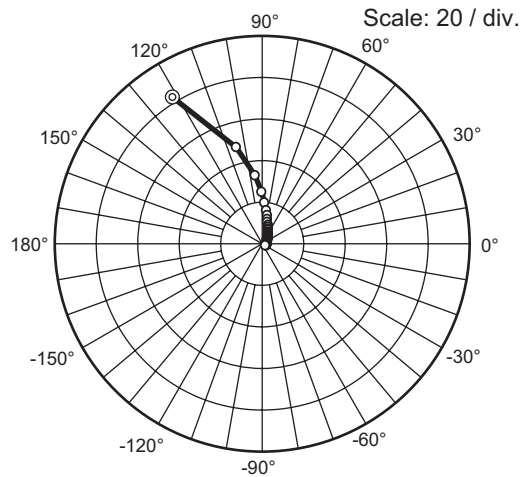
Condition:  $V_{CE} = 3.3\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>11</sub> Parameter vs. Frequency



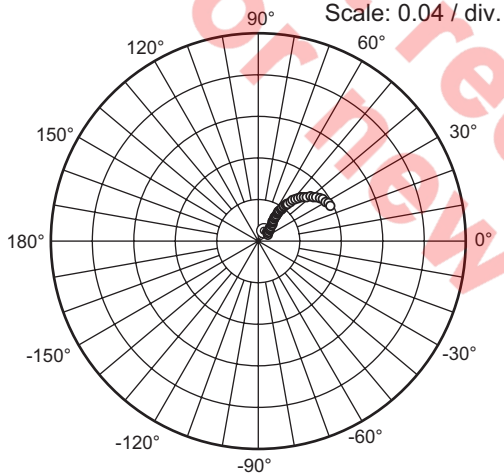
Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>21</sub> Parameter vs. Frequency



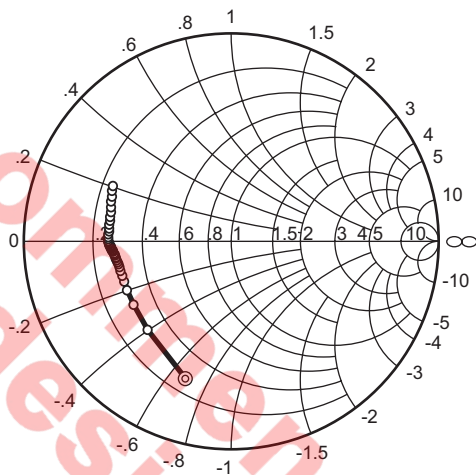
Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>12</sub> Parameter vs. Frequency



Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

S<sub>22</sub> Parameter vs. Frequency



Condition:  $V_{CE} = 3.6\text{ V}$ ,  $I_C = 100\text{ mA}$ ,  $Z_o = 50\ \Omega$   
 100 to 3000 MHz (100 MHz Step)  
 3200 to 6000 MHz (200 MHz Step)

## S parameter

 $(V_{CE} = 3 \text{ V}, I_C = 100 \text{ mA}, Z_o = 50 \Omega)$ 

f (MHz)	S11		S21		S12		S22	
	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)
100	0.687	-139.8	77.53	120.52	0.0084	45.8	0.682	-105.5
200	0.775	-160.8	47.14	104.05	0.0106	28.1	0.598	-134.6
300	0.786	-169.2	32.99	96.02	0.0107	33.1	0.566	-148.2
400	0.792	-174.5	24.95	91.32	0.0127	39.8	0.559	-155.7
500	0.797	-178.1	19.96	87.93	0.0129	39.0	0.559	-160.4
600	0.802	179.0	16.62	85.12	0.0139	41.5	0.560	-163.5
700	0.803	176.6	14.22	82.63	0.0155	42.8	0.560	-165.9
800	0.804	174.2	12.41	80.38	0.0163	48.0	0.561	-167.7
900	0.802	171.9	10.98	78.31	0.0176	49.1	0.563	-169.1
1000	0.804	169.8	9.81	76.55	0.0191	50.1	0.565	-170.4
1100	0.807	168.1	8.89	74.86	0.0201	51.0	0.567	-171.4
1200	0.809	166.5	8.11	73.18	0.0214	51.7	0.568	-172.3
1300	0.809	164.8	7.47	71.47	0.0230	52.7	0.570	-173.0
1400	0.809	163.1	6.91	69.76	0.0244	53.8	0.572	-173.8
1500	0.809	161.2	6.43	68.18	0.0257	53.0	0.573	-174.5
1600	0.811	159.5	6.00	66.70	0.0275	54.4	0.576	-175.1
1700	0.814	158.1	5.62	65.37	0.0280	54.6	0.578	-175.6
1800	0.817	156.9	5.29	63.93	0.0295	54.2	0.579	-176.0
1900	0.817	155.6	5.00	62.42	0.0314	54.2	0.581	-176.4
2000	0.816	154.0	4.74	60.74	0.0324	54.5	0.583	-176.9
2100	0.814	152.3	4.49	59.29	0.0335	54.4	0.584	-177.3
2200	0.817	150.8	4.28	57.89	0.0350	53.9	0.586	-177.7
2300	0.820	149.5	4.08	56.76	0.0364	53.1	0.587	-178.0
2400	0.824	148.4	3.90	55.44	0.0381	53.8	0.590	-178.4
2500	0.825	147.3	3.73	54.01	0.0389	53.4	0.591	-178.7
2600	0.823	145.8	3.58	52.41	0.0405	52.5	0.591	-179.0
2700	0.822	144.3	3.44	50.91	0.0416	52.6	0.593	-179.4
2800	0.822	142.8	3.30	49.54	0.0432	52.5	0.594	-179.8
2900	0.824	141.5	3.18	48.34	0.0440	51.5	0.595	179.9
3000	0.827	140.4	3.07	47.15	0.0458	51.0	0.596	179.5
3200	0.828	137.9	2.87	44.27	0.0481	50.3	0.596	178.8
3400	0.824	134.8	2.68	41.22	0.0509	49.1	0.596	178.0
3600	0.826	132.4	2.53	38.75	0.0539	48.0	0.597	177.0
3800	0.827	129.6	2.39	35.90	0.0562	46.1	0.597	175.8
4000	0.826	126.2	2.25	32.65	0.0587	44.6	0.597	174.5
4200	0.830	123.6	2.13	29.93	0.0608	43.6	0.596	173.0
4400	0.830	120.8	2.03	27.16	0.0632	41.6	0.596	171.3
4600	0.832	117.3	1.92	23.82	0.0656	40.2	0.597	169.4
4800	0.839	114.6	1.82	20.87	0.0675	38.3	0.599	167.4
5000	0.841	111.9	1.74	18.04	0.0699	36.1	0.601	165.3
5200	0.843	108.6	1.65	14.81	0.0719	34.1	0.606	163.1
5400	0.851	106.1	1.56	11.85	0.0734	32.2	0.612	160.9
5600	0.854	103.6	1.49	8.83	0.0750	29.8	0.618	158.5
5800	0.856	100.5	1.41	5.79	0.0763	27.5	0.624	156.3
6000	0.862	98.4	1.34	2.79	0.0776	25.4	0.631	153.9

## S parameter

 $(V_{CE} = 3.3 \text{ V}, I_C = 100 \text{ mA}, Z_o = 50 \Omega)$ 

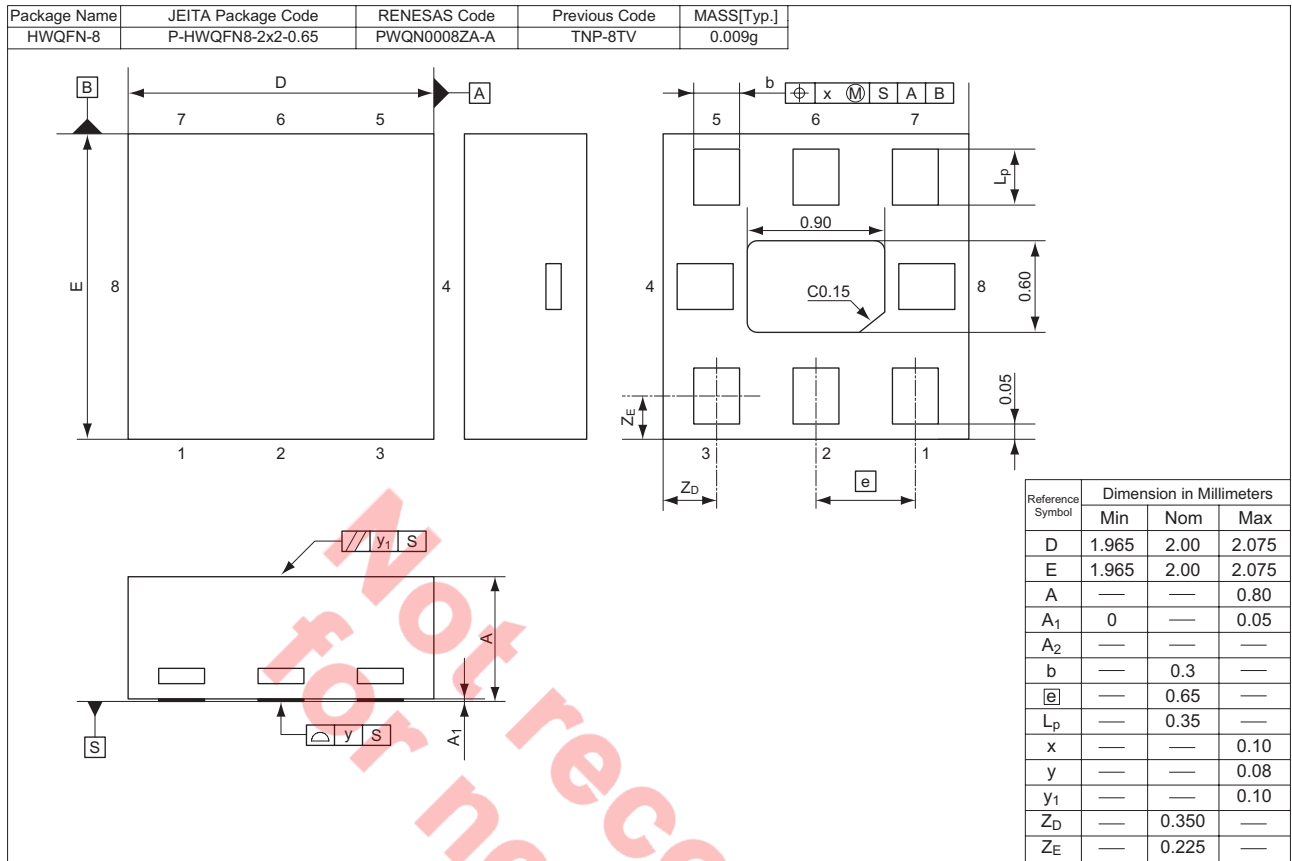
f (MHz)	S11		S21		S12		S22	
	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)
100	0.675	-140.9	80.79	120.97	0.0127	40.9	0.626	-109.1
200	0.771	-160.6	48.16	104.58	0.0091	37.0	0.594	-134.0
300	0.785	-168.9	33.50	96.32	0.0110	34.4	0.561	-147.6
400	0.790	-174.3	25.29	91.50	0.0128	37.4	0.554	-155.1
500	0.794	-178.0	20.21	88.06	0.0135	41.0	0.553	-159.7
600	0.800	179.2	16.83	85.22	0.0140	42.0	0.553	-163.0
700	0.802	176.7	14.40	82.70	0.0157	44.5	0.554	-165.4
800	0.802	174.3	12.56	80.43	0.0169	47.1	0.555	-167.2
900	0.801	172.0	11.11	78.33	0.0177	49.5	0.557	-168.8
1000	0.802	170.0	9.93	76.55	0.0191	52.1	0.559	-170.0
1100	0.805	168.2	8.99	74.86	0.0204	50.3	0.561	-171.0
1200	0.808	166.6	8.20	73.16	0.0211	51.6	0.563	-171.9
1300	0.808	164.9	7.56	71.44	0.0228	52.5	0.564	-172.7
1400	0.808	163.1	6.99	69.73	0.0247	53.4	0.566	-173.4
1500	0.807	161.3	6.51	68.13	0.0252	53.4	0.567	-174.0
1600	0.809	159.6	6.07	66.63	0.0268	53.9	0.570	-174.7
1700	0.813	158.3	5.68	65.30	0.0281	53.8	0.572	-175.2
1800	0.816	157.0	5.35	63.86	0.0294	54.0	0.574	-175.7
1900	0.816	155.7	5.05	62.34	0.0309	53.8	0.575	-176.1
2000	0.814	154.1	4.79	60.66	0.0323	54.4	0.578	-176.5
2100	0.813	152.4	4.55	59.20	0.0335	54.6	0.579	-176.9
2200	0.816	150.9	4.33	57.79	0.0348	54.0	0.581	-177.3
2300	0.819	149.6	4.12	56.67	0.0362	53.4	0.582	-177.7
2400	0.823	148.5	3.94	55.32	0.0378	53.2	0.584	-178.0
2500	0.824	147.3	3.77	53.88	0.0391	52.9	0.586	-178.3
2600	0.822	145.9	3.62	52.28	0.0409	53.1	0.586	-178.6
2700	0.820	144.3	3.47	50.76	0.0422	52.6	0.588	-179.0
2800	0.821	142.9	3.34	49.39	0.0423	52.1	0.589	-179.4
2900	0.823	141.6	3.22	48.20	0.0444	51.8	0.590	-179.7
3000	0.826	140.5	3.11	47.01	0.0457	51.4	0.591	180.0
3200	0.827	137.9	2.90	44.10	0.0480	50.6	0.592	179.3
3400	0.823	134.9	2.71	41.04	0.0512	49.0	0.592	178.4
3600	0.826	132.4	2.55	38.57	0.0533	47.8	0.593	177.4
3800	0.826	129.6	2.41	35.71	0.0558	46.9	0.592	176.3
4000	0.826	126.3	2.28	32.44	0.0588	45.3	0.593	175.0
4200	0.830	123.7	2.16	29.71	0.0609	43.6	0.592	173.4
4400	0.829	120.8	2.05	26.93	0.0629	41.7	0.592	171.8
4600	0.831	117.3	1.94	23.60	0.0648	40.0	0.593	169.8
4800	0.838	114.7	1.84	20.64	0.0674	38.3	0.595	167.8
5000	0.841	112.0	1.76	17.79	0.0696	36.7	0.598	165.8
5200	0.842	108.7	1.66	14.56	0.0719	34.5	0.603	163.5
5400	0.850	106.1	1.58	11.59	0.0731	32.2	0.608	161.3
5600	0.855	103.6	1.51	8.56	0.0746	29.9	0.615	159.0
5800	0.856	100.5	1.43	5.51	0.0762	27.7	0.621	156.7
6000	0.862	98.4	1.35	2.51	0.0770	25.6	0.629	154.3

## S parameter

 $(V_{CE} = 3.6 \text{ V}, I_C = 100 \text{ mA}, Z_o = 50 \Omega)$ 

f (MHz)	S11		S21		S12		S22	
	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)	MAG	ANG (deg.)
100	0.669	-141.0	82.98	121.53	0.0107	60.0	0.695	-107.8
200	0.763	-160.3	48.82	105.15	0.0118	37.6	0.583	-133.1
300	0.781	-168.8	33.85	96.65	0.0104	31.8	0.556	-146.8
400	0.787	-174.2	25.53	91.73	0.0110	37.4	0.550	-154.7
500	0.793	-177.9	20.40	88.22	0.0131	38.2	0.548	-159.3
600	0.799	179.3	16.98	85.36	0.0145	43.2	0.548	-162.5
700	0.800	176.8	14.52	82.79	0.0157	44.8	0.549	-165.0
800	0.801	174.4	12.67	80.50	0.0165	46.4	0.550	-166.9
900	0.800	172.1	11.21	78.40	0.0172	47.4	0.552	-168.4
1000	0.801	170.0	10.02	76.59	0.0190	49.6	0.553	-169.7
1100	0.804	168.3	9.07	74.88	0.0203	48.8	0.556	-170.7
1200	0.807	166.7	8.27	73.18	0.0216	52.1	0.558	-171.6
1300	0.807	165.0	7.62	71.44	0.0228	53.0	0.560	-172.3
1400	0.806	163.2	7.06	69.72	0.0242	53.8	0.561	-173.1
1500	0.806	161.3	6.56	68.12	0.0255	53.7	0.563	-173.7
1600	0.809	159.7	6.12	66.61	0.0268	54.4	0.565	-174.3
1700	0.812	158.3	5.73	65.26	0.0282	54.9	0.567	-174.9
1800	0.814	157.1	5.39	63.81	0.0297	54.0	0.569	-175.3
1900	0.815	155.7	5.10	62.28	0.0311	54.1	0.571	-175.7
2000	0.813	154.1	4.83	60.60	0.0324	54.4	0.573	-176.1
2100	0.812	152.5	4.58	59.13	0.0335	54.2	0.575	-176.6
2200	0.814	150.9	4.36	57.72	0.0348	54.2	0.577	-177.0
2300	0.818	149.7	4.16	56.58	0.0365	53.4	0.578	-177.3
2400	0.822	148.5	3.98	55.23	0.0381	53.5	0.580	-177.6
2500	0.822	147.3	3.81	53.78	0.0389	53.4	0.581	-178.0
2600	0.821	145.9	3.65	52.18	0.0402	53.0	0.583	-178.3
2700	0.820	144.4	3.50	50.66	0.0416	53.2	0.584	-178.7
2800	0.819	142.9	3.37	49.28	0.0429	51.7	0.585	-179.0
2900	0.822	141.6	3.24	48.08	0.0443	51.9	0.586	-179.3
3000	0.825	140.5	3.13	46.89	0.0453	51.2	0.587	-179.7
3200	0.826	137.9	2.92	43.98	0.0482	50.0	0.588	179.6
3400	0.823	134.9	2.73	40.91	0.0505	49.5	0.589	178.7
3600	0.825	132.5	2.57	38.42	0.0533	48.0	0.589	177.8
3800	0.825	129.7	2.43	35.54	0.0559	46.2	0.589	176.6
4000	0.825	126.3	2.29	32.27	0.0582	45.6	0.589	175.3
4200	0.829	123.7	2.17	29.53	0.0603	43.9	0.589	173.8
4400	0.828	120.9	2.06	26.75	0.0627	41.8	0.589	172.1
4600	0.830	117.4	1.95	23.41	0.0653	40.4	0.590	170.2
4800	0.838	114.7	1.85	20.45	0.0671	38.2	0.592	168.2
5000	0.840	112.0	1.77	17.60	0.0694	36.3	0.595	166.1
5200	0.842	108.7	1.68	14.35	0.0712	34.3	0.599	163.9
5400	0.850	106.1	1.59	11.39	0.0730	32.3	0.606	161.6
5600	0.854	103.6	1.52	8.34	0.0749	29.6	0.612	159.3
5800	0.856	100.5	1.44	5.27	0.0761	28.1	0.619	157.0
6000	0.861	98.4	1.36	2.29	0.0768	25.7	0.626	154.7

### Package Dimensions



### Ordering Information

Part Name	Quantity	Shipping Container
HSG2005TB-E	2000 pcs.	φ178 mm Reel, 8 mm Emboss taping

Note: Therefore especially small contact area of terminal, miss contact may occur if inadequate soldering condition is applied.

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